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High Efficiency, High Density, PolyPhase Converters for High Applications

Wei Chen

Introduction

As logic systems get larger and more complex, their supply current requirements increase. Systems requiring 100A are fairly common. A high current power supply to meet these requirements usually requires paralleling several power regulators to alleviate the individual power components. A power supply designer is left with the choice of using these paralleled regulators: brute-force single-phase or smart PolyPhase™. PolyPhase™ interleaves the clock signals of the paralleled power stages, reducing input current without increasing the switching frequency. The decreased power loss in the input capacitor and the low switching losses associated with MOSFETs at low frequencies help achieve high power conversion efficiency. The size and cost of the capacitors are also greatly reduced as a result of input ripple current cancellation. Input ripple current cancellation also occurs, lower value inductors can be used. The dynamic response to load transients. A combination of lower current rating and inductance also allows the use of smaller-sized, low profile, surface mount multioutput applications, PolyPhase converters may also provide the benefit of smaller capacitors.

Previously, the implementation of multiphase designs was difficult and expensive due to complex timing and current-sharing requirements. The newly developed LTC1628 and LTC1629 address these problems for high current, single output designs, while the LTC1628 addresses more complex applications. Both ICs are dual, current mode, PolyPhase controllers that can drive up to four synchronous buck stages simultaneously. The features of the LTC1629 include a differential amplifier for true remote sensing, low impedance gate drives, current limit protection, overvoltage protection, optional overcurrent latch-off and foldback current limit. The LTC1629 can be configured for 2-, 3-, 4-, 6- and 12-phase operation with a phase selection signal (high, low or open). Optimizing the number of phases can help achieve the most cost-effective power supply design.

This application note analyzes the performance of PolyPhase converters and provides guidelines for selecting the phase number and designing a PolyPhase converter using them. The following questions will be answered as the discussion goes on:

- How much do I gain by using a PolyPhase architecture?
- How many phases are needed for a given application?
- How do I design a PolyPhase converter?

How Do Polyphase Techniques Effect Circuit Performance?

In general, PolyPhase operation improves the large signal performance of a converter, by such means as reducing ripple current and ripple voltage. A [switching converter](#) is used as an example in this application note to analyze the effects of these techniques on circuit performance.

High current outputs usually require paralleling several regulators. The single regulator approach is not feasible because of the unacceptable thermal stress on the individual power devices. Paralleled regulators are synchronized to have the same switching frequency to reduce the total frequency noise at both the input and output terminals. Based on the phase shift technique, the parallel regulators are synchronized to have a 180° phase shift between them.

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